

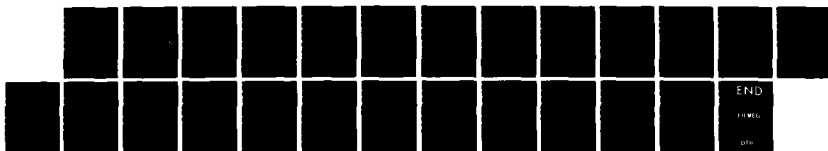
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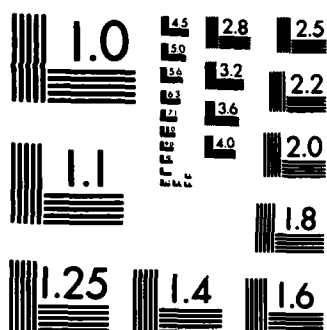
GORDON RESEARCH CONFERENCE ON COMPOSITES (1984) HELD AT 171  
SANTA BARBARA CAL. (U) GORDON RESEARCH CONFERENCES INC  
R J FARRIS DEC 84 ARO-21152.1-M5-CF DAAG29-83-M-0415

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARO 21152.1-MS-CF	2. GOVT ACCESSION NO. AD-A152 888	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 1984 Gordon Research Conference on Composites		5. TYPE OF REPORT & PERIOD COVERED 1 Nov 83 - 30 Apr 84 Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Richard J. Farris		8. CONTRACT OR GRANT NUMBER(s) DAAG29-83-M-0415
9. PERFORMING ORGANIZATION NAME AND ADDRESS Gordon Research Conferences, Inc. Univ. of Rhode Island Kingston, RI 02881		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS N/A
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Army Research Office Post Office Box 12211 Research Triangle Park, NC 27709		12. REPORT DATE Dec 84
		13. NUMBER OF PAGES 23
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report)  Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report)  Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)  E		
18. SUPPLEMENTARY NOTES  The view, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)  Composite Materials Conferences. <		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  The Gordon Research Conference on Composites was held in Santa Barbara, California during the period January 16-20, 1984. The conference is an annual Gordon Conference and has been held yearly on the West Coast since its inception in 1975. The conference had as its main purpose or theme, the science and engineering of tough composites. The conferees and speakers represented a good mix of the chemistry, materials science, physics and engineering disciplines which was the original intent. The papers presented were unpublished original works, as required by the conference regulations, and contained considerable new and not yet understood scientific results.		

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Final Report: 1984 Gordon Research Conference on Composites, ARO Proposal  
No. 21152-MS

Prepared by: Richard J. Farris, Professor  
Polymer Science and Engineering Department  
University of Massachusetts, Amherst  
Chairman 1984 Gordon Research  
Conference on Composites

### Introduction

The Gordon Research Conference on Composites was held in Santa Barbara, California at the Miramar Hotel during the period January 16-20, 1984. The conference is an annual Gordon Conference and has been held yearly on the West Coast since its inception in 1975. Financial support for these conferences is provided by the Gordon Research Conferences at a level of \$7500. Additional support was solicited in the form of a proposal to the U.S. Army Research Office as well as the U.S. Navy, ONR and the U.S. Air Force, AFOSR. Additional support received was from the U.S. Army which provided \$6000 to aid in travel and conference fee expenses for conferees. The combined \$13,500 was used entirely for support of travel and conference fees for 27 participants. The average support for these conferees was \$500. The conference was a big success according to reports I have received and had as its main purpose or theme, the science and engineering of tough composites. The conferees and speakers represented a good mix of the chemistry, materials science, physics and engineering disciplines which was the original intent. This conference is perhaps the only conference of its type which brings to bear the talents of such a wide variety of disciplines to attack a particular subject in the true Gordon Research Conference spirit, to challenge the frontiers of science and current concepts. The papers presented were unpublished original works, as required by the conference regulations, and contained considerable new and not yet understood scientific results.

According to Gordon Research regulations there are no conference preprints or final printed papers. Equal time was given for presentation and discussion.

#### Conference Program

A copy of the conference program is attached as Appendix A. There were seventeen invited speakers, five from industry, seven from Universities, and five from Government laboratories. Three of the speakers were from foreign countries, two from England and one from Japan. Each speaker gave a 45-minute talk and had another 45 minutes for discussion. A special "Short Presentation" schedule was arranged for the Thursday evening meeting where five additional short talks were given. A panel discussion on "Needs in Composites" was also held Thursday evening with four prominent scientists leading the discussion. The program went as planned and was effective in setting the atmosphere for the discussion periods which often-times continued all afternoon or into the early morning hours.

#### Attendance

The 1984 Gordon Research Conference on Composites was attended by 119 conferees. This was the largest Composites Gordon Conference ever held. The attendance in 1975 was approximately 60 conferees and the applications have been increasing annually. A list of the conferees is attached as appendix B. A breakdown by affiliation gives 77 from industry, 15 from Government Laboratories, and 27 from Universities. There were 12 conferees from foreign countries which included England, Belgium, Israel, Japan, France, Denmark and West Germany. Examination of Appendix B shows that essentially all of the major aircraft companies and government laboratories were present as well as major universities doing composites research.



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### Finances

The conference was supported by the Gordon Research Conferences (\$7500) and by U.S. Army Research Office (\$6000). The combined \$13,500 was spent giving assistance to 27 conferees who requested assistance. This amounted to an average of \$500 per conferee who was aided. Gordon Research Policy requires that their \$7500 be used prior to any other funds. These funds made it possible to invite foreign speakers and to defer travel and conference expenses for those otherwise able to attend. A list of those receiving support is given in Appendix C.

### Future Conferences

According to the guidelines established by the Gordon Research Conferences, a business section was held Thursday evening. The conferees voted unanimously to hold the conference again next year at the same location and as in the past, the week following the Polymers Conference. Professor John Edmund (Ed) Fitzgerald of Georgia Institute of Technology, who served as vice-chairman for this meeting, will chair and organize the 1985 meeting and Dr. Clarence Wolf, McDonnell-Douglas Corporation, was elected to serve as vice-chairman in 1985.

### Summary of Meeting

The primary objective of this meeting was to bring together the various disciplines involved in composites to address future trends and needs, especially in the area of tough-high performance composites. A deliberate effort was made to include chemists and physicists in the program as this conference had been becoming more and more engineering-oriented each year. Gordon Conferences are chemical conferences and the continuation of this conference demands that it retain some association with chemistry.

The first eight papers, Monday and Tuesdays program, were devoted to tough composites, especially those using thermoplastic matrix materials such as PEEK and rubber toughened epoxies. The Monday program, Drs. Sternstein, Nairn, Yee and Filippov, was devoted to understaind toughening mechanisms. The Tuesday morning program, Drs. Kenner, Elber, McKenna and Wu was devoted to evaluation of toughness and factors not commonly considered that can influence toughness, such as physical ageing and voids. Dr. Elber addressed why tough composites were required and the benefits that could be achieved if they were available. The Tuesday evening program, Drs. Drzal and Karasz, addressed the problem of moisture with regards to adhesion and lowering of the glass transition temperature.

A new type of composite, Molecular composites, was introduced on Wednesday morning by Drs. Takayanagi and Hwang. These composites are essentially a thermoplastic matrix reinforced with rigig-rod molecules. They are like chopped fiber composites except the reinforcement is not fibers but rather molecules or small bundles of molecules. This concept is still in its infancy but rather remarkeable properties can be achieved.

On Wednesday evening Drs. Gent and Brookstein discussed two different types of composites, Gent - elastomeric matrix materials and Brookstein - braided composites. Gent's discussion clearly showed the necessity of using fracture mechanics and an energetic approach to adhesion. Brookstein discussed braided composites as an alternative to filament winding. The primary advantages are an interlocking woven like structure, the ability to use irregular mandrels and the ability to deposit mateiral at a very high rate (speed of construction).

Thursday morning was devoted to macromechanics of deformation, Dr. Peter Beaumont, and the long-term life of composites under tension, Dr. T.T. Chiao.

Dr. Beaumont showed some TV recordings of high resolution-scanning electron microscopy of cracks developing and growing. This view clearly illustrated the damage zone can extend a considerable distance in all directions from the crack zone. Dr. Chiao, using statistics of fracture, demonstrated the need to improve variability of fiber materials and their composites. He stressed that large improvements in narrowing the statistics of fracture would lead to the same advantages in design as increases in properties.

The Thursday evening session was occupied by the business meeting, short presentations from the conferees, and a panel discussion on future directions and needs of the composites community. The panel was led by Drs. Sternstein, Bascom, Barry and Wilkins.

The Friday morning session was devoted to compression failure of composites (Dr. Chaplin) who demonstrated that in many cases compression failure is an elastic instability and not a true fracture. Such instabilities are occurring in the fibers. He discussed methods of improving these properties and showed why such instabilities occur. Dr. Jortner introduced the conference to carbon-carbon composites and the problems associated with microcracking and graphitization. These carbon-carbon composites are amazingly tough for such brittle constituents and suggested there may be room for improvements in these properties with what polymeric based scientists consider brittle matrix materials.

#### Problems

The only problem really associated with this conference is freedom of information/open discussion. Two papers originally scheduled were cancelled because of lack of clearance. Every year this seems to cause more and more difficulty since we are always trying to get the latest science and technology



discussed and presented. The problem is mostly company and government oriented since universities will normally not accept monies with publication restrictions. What is most distressing is that these conferences were established to aid in the development and understanding of composites, and a more talented collection of scientists and engineers than the conferees would be difficult to find. Yet each year papers promised to be delivered are at the last minute withdrawn because of a refused government clearance or a corporate decision. There is probably little that can be done about this situation but it is nonetheless frustrating to organizers and speakers and greatly hinders the scientific discussion.

APPENDIX A: CONFERENCE PROGRAM

GORDON RESEARCH CONFERENCE

ON

COMPOSITES

January 16-20, 1984  
Miramar Hotel, Santa Barbara, California

Richard J. Farris, Chairperson  
1. Edmund Fitzgerald, Vice-Chairperson

Monday Morning, January 16

Discussion Leader: Willard Bascom, Hercules, Inc.

The Mechanical Properties of Thermo-  
plastic Matrix Composites

S.S. Sternstein  
Rensselaer Polytechnic Inst.

Thermoplastics as Matrix Resins for  
Advanced Composites

John Nairn  
E.I. duPont de Nemours & Co.

Monday Evening, January 16

Discussion Leader: Richard M. Ikeda, E.I. duPont de Nemours & Co.

Toughening Mechanism in Elastomer-  
Modified Epoxy Resins

Albert F. Yee  
General Electric Co.

Toughness of Composites with Epoxy  
Matrices

Andrei G. Filippov  
Shell Development Co.

Tuesday Morning, January 17

Discussion Leader: Richard M. Christensen, Lawrence Livermore Labs

Fracture Evaluation of Thermosetting  
Resins and Their Composites

Vernal H. Kenner  
Ohio State University, Columbus

The Need for Tough Composites

Wolf Elber  
Materials Division, NASA Langely

Physical Ageing of a Thermoplastic  
Resin in the Nonlinear Range

Greg McKenna  
Polymer Division, National  
Bureau of Standards

Application of Small Angle Scattering  
to Composites

Wen-Li Wu  
Polymer Division, National  
Bureau of Standards

Tuesday Evening, January 17

Discussion Leader: Tisato Kajiyama, Kyushu University, Japan

Interface Response to Hygrothermal  
Environment

Lawrence T. Drzal  
Air Force Wright Aeronautical  
Labs

Epoxy-Water Interactions

Frank E. Karasz  
University of Massachusetts,  
Amherst

Wednesday Morning, January 18

Discussion Leader: Dusan Prevorsek, Allied Corporation

Preparation, Properties and Analyses  
of Moduli of Molecular Composites

Motowo Takayanagi  
Kyushu University, Japan

Rigid-Rod Molecular Composites

Wen Fang Hwang  
University of Dayton Research  
Institute

Wednesday Evening, January 18

Discussion Leader: Richard H. Ericksen, Sandia Laboratories

Fracture Mechanics of Elastomeric  
Composites

Alan N. Gent  
University of Akron

Strength, Stability and Attachment  
Considerations in Braided  
Composite Structures

David Brookstein  
Albany International Res. Co.

Thursday Morning, January 19

Discussion Leader: Zvi Hashin, Tel-Aviv University, Israel

Micromechanisms of Deformation and  
Fracture of Polymers and Polymer  
Composites

Peter Beaumont  
Cambridge University, England

Lifetime of Fiber Composites Under  
Tension

T.T. Chiao  
Lawrence Livermore Labs

Thursday Evening, January 19

Discussion Leader: J. Edmund Fitzgerald, Georgia Inst. of Technology

Short presentations from Conference Attendees

Ionizing Radiation Effects on Carbon Fiber/Epoxy Composites	Raymond Fornes North Carolina State University
A Dielectric Study of the Time- Temperature-Transformation (TTT) Diagram of DGEBA-DDS	Stephen D. Senturia Massachusetts Institute of Technology
Thermal Expansion of Glass Fiber Polyester	Hans Lilholt RISØ National Laboratory, Denmark
Failures of Kapton Insulated Electrical Insulations in Hot-Wet Environments	Clarence Wolf McDonnell Douglas Corporation
An Impulse Approach to Viscoelasticity	Richard J. Farris University of Massachusetts

General Discussion on Needs in Composites

Opening comments by:

Sanford S. Sternstein	Rensselaer Polytechnic Institute
Willard Bascon	Hercules, Inc.
William Barry	Consultant
Dick J. Wilkins	General Dynamics

Friday Morning, January 20

Discussion Leader: Dick J. Wilkins, General Dynamics

Compression-Failure Mechanics of Composites	Richard Chaplin University of Reading, England
Causes and Effects of Microcracking in Carbon-Carbon Composites	Julius Jortner Jortner Res. & Eng., Inc.

# SPEAKERS

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# SPEAKERS

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## DISCUSSION LEADERS

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# SHORT PRESENTATIONS

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APPENDIX B: LIST OF CONFEREES

## GORDON RESEARCH CONFERENCES

## COMPOSITES

January 16 - 20, 1984  
 Miramar Hotel  
 Santa Barbara, California

## Registration List

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